

SECTION 16120

BUILDING WIRE AND CABLE

LANL MASTER CONSTRUCTION SPECIFICATION

When editing to suit Project, author shall add job-specific requirements and delete only those portions that in no way apply to the activity (e.g., a component that does not apply). To seek a variance from applicable requirements, contact the Engineering Standards Manual (ESM) Electrical POC. Refer to

http://www.lanl.gov/f6stds/pubf6stds/engrman/HTML/poc_techcom1.htm#elec for the Engineering Standards Manual Personnel Link Index.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Delete information within "stars" during editing.

Specification developed for ML-3 / ML-4 projects. For ML-1 / ML-2, additional requirements and QA reviews are required.

PART 1 GENERAL

1.1 SECTION INCLUDES

Edit article to match Project requirements. Delete items not applicable to Project.

- A. Building wire
- B. Metal-clad cable
- C. Wire and cable connectors
- D. Insulating tape and tubing

1.2 LANL PERFORMED WORK

- A. None

1.3 QUALITY ASSURANCE

- A. Comply with the *National Electrical Code* (NEC) for components and installation.
- B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application and environment in which installed.

1.4 RECEIVING, STORING AND PROTECTING

- A. Receive, store, and protect, and handle products according to NECA 1 *Standard Practices for Good Workmanship in Electrical Construction*.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Refer to Section 01630.

2.2 BUILDING WIRE

- A. Provide building wire as shown on the Drawings with the following characteristics:

1. Description: Single conductor insulated wire.
2. Conductor: 98% conductivity, annealed, uncoated copper, solid or stranded as specified in Part 3 of this Section.
3. Insulation: The following types, rated 600 volts:
 - a. 2 AWG and smaller, Type THHN/THWN per UL Standard 83 *Thermoplastic Insulated Wires*.
 - b. 1 AWG and larger, Type THHN/THWN per UL Standard 83 or Type XHHW per UL Standard 44 *Rubber Insulated Wires and Cables*.

Edit the following Article to match Project requirements. Delete if not applicable to Project.

4. Refer to Section 13852 Addressable Fire Alarm System for fire alarm system conductor requirements.

- B. Color code conductors as follows:

1. Use colored insulation for color coding conductors 6 AWG and smaller.
2. Use water and oil resistant colored plastic adhesive tape, 3/4 inch minimum width, for color coding conductor 4 AWG and larger. Manufacturer: 3M "Scotch 35"
3. Provide black conductor insulation where colored tape is used for color coding.
4. Use the following color codes for AC power system conductors:

	<u>208Y/120V System</u>	<u>480Y/277V System</u>
Phase A:	Black	Brown
Phase B:	Red	Orange
Phase C:	Blue	Yellow
Neutral:	White	Gray
Equipment Ground:	Green	Green
Isolated Ground:	Green/Yellow	Green/Yellow

5. Use the following color codes for DC power system conductors:

Positive: Red
Negative: Black

Edit the following Article to match Project requirements. Delete if not applicable to Project.

6. In existing facilities, change color coding of existing service, feeder, and major branch circuits (50 amps and larger) to match the above color code.
7. Provide color code for control conductors as indicated on equipment or control system manufacturer's drawings.

Type MC cable may be used in IBC Group B occupancies for 15 and 20 ampere branch circuit wiring systems beyond the first outlet box. Refer to Section D5010 in the LANL Engineering Standards for additional information. Delete this article when Type MC is not used.

2.3 METAL-CLAD CABLE

- A. Provide metal-clad cable (Type MC) that complies with UL Standard 1569, the NEC, and this Section.
- B. Metal-clad cable shall consist of THHN insulated solid copper conductors, a Mylar wrapping around the conductor bundle, and a close fitting aluminum or galvanized steel outer sheath.
- C. Provide minimum 12 AWG conductors in Type MC cables.
 1. Provide larger conductor sizes as required to limit branch circuit voltage drop to 3 percent at the full connected load.
 2. Use larger conductor sizes to adjust allowable ampacity if there are more than 3 current-carrying conductors in a cable.
 3. For isolated ground power circuits provide Type MC cables with a separate neutral conductor for each phase conductor; uniquely identify each neutral with a colored stripe on the white insulation corresponding to the phase conductor insulation color.
- D. Provide MC cables with the same conductor color coding as specified for BUILDING WIRE AND CABLE.
- E. Metal-clad cable manufacturer: AFC Cable Systems Inc.
- F. Provide NRTL listed, insulated throat, snap-in steel box connectors for Type MC cables. Manufacturer: O-Z/Gedney ETP "Speed-Lock".

2.4 WIRING CONNECTORS

- A. For splices and taps on wire sizes 8 AWG and smaller use solderless insulated, spring type connectors, rated 600 volts and 105 °C. Manufacturer: 3M "Scotchlock"
- B. For splices and taps on wire sizes 6 AWG through 1 AWG use tin-plated copper split-bolt connectors that meet the requirements in UL 486A. Manufacturer: FCI "KSA"
- C. For wire sizes 1/0 AWG and larger use circumferential compression connectors that meet the requirements in UL 486A. Provide lugs and splices made from electro-tin plated seamless copper tubing and marked with cable accommodation, die codes and crimp locations. Manufacturer: FCI "YA", "YA-L", "YA-L-NT", and "YS"

- D. For control wiring use nylon insulated crimp-on terminals that meet the requirements of UL 486A with insulation grip and brazed seam. Manufacturer: 3M type "MNG"
 - 1. Use ring tongue terminals for nutted studs.
 - 2. Use flanged fork terminals for barrier terminal strips.
 - 3. Use pin terminals for DIN type terminal blocks.

2.5 INSULATING TAPE AND TUBING

- A. Provide vinyl plastic tape that meets the requirements of UL 510 and has the following characteristics:
 - 1. 8.5 mil minimum thickness,
 - 2. *ASTM D-3005 Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape – Type 1*
 - 3. Rated 600 volts and 105 °C, suitable for indoor and outdoor applications,
 - 4. Retains flexibility, adhesion, and applicable at temperature ranges from 0 through 100 °F without loss of physical or electrical properties,
 - 5. Resistant to abrasion, moisture, alkalis, acid, corrosion, and sunlight.
 - 6. Manufacturer: 3M "Scotch Super 88"
- B. Provide heat shrinkable tubing that meets the requirements of UL 486D and has the following characteristics:
 - 1. Rated 1kV
 - 2. Factory applied adhesive/sealant
 - 3. Flame retardant
 - 4. Manufacturer: 3M "MDT"
- C. Use motor lead splicing kits to insulate and seal connections to leads for motors rated 480V and less. Manufacturer: 3M "5300 Series"

2.6 WIRE PULLING LUBRICANT

- A. Provide wire pulling lubricant that is compatible with conductor insulation, has a maximum coefficient of friction of 0.055, and is stable up to a temperature of 180 °F. For cold weather installations, provide wire pulling lubricant suitable for conduit temperature.
- B. Compatibility with conductor insulation shall be determined in accordance with IEEE Std 1210 *Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable*.

- C. Manufacturer: IDEAL "Yellow 190" or "Aqua-Gel CW"

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify interior of building has been protected from weather.
- B. Verify that work of other trades likely to damage wire and cable has been completed.
- C. Verify raceway installation is complete and supported.
- D. Verify that field measurements are as shown on Drawings.
- E. Wire and cable routing shown on Drawings is approximate unless dimensioned.
 - 1. Route wire and cable as required meeting project conditions.
 - 2. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required to meet project conditions.

3.2 PREPARATION

- A. Examine raceways and building finishes that are to receive wires and cables for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Completely and thoroughly swab raceway before installing wire.
- C. Store cable for 24 hours in the installation area ambient temperature before installing.

3.3 EXISTING WORK

Delete this article when existing construction is not affected.

- A. Remove exposed abandoned wire and cable, including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes.
- B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.
- C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.
- D. Extend existing circuits using materials and methods as specified.

3.4 BUILDING WIRE INSTALLATION

- A. Install building according to NECA 1 *Standard Practices for Good Workmanship in Electrical Construction*, the NEC, and requirements in this Section.
- B. Use solid conductors for power circuits 10 AWG and smaller except use stranded conductors in flexible conduits.
- C. Use stranded conductors for power circuits 8 AWG and larger.
- D. Use stranded conductors for control circuits.
- E. Use conductors not smaller than 12 AWG for power and lighting circuits.
- F. Use conductors not smaller than 14 AWG for 120V control circuits.
- G. Use conductors not smaller than 16 AWG for 24V control circuits.
- H. Use 10 AWG conductors from panelboard to first outlet for 20 ampere, 120 volt branch circuits longer than 75 feet.
- I. Use 10 AWG conductors from panelboard to first outlet for 20 ampere, 277 volt branch circuits longer than 150 feet.
- J. Do not "through-pull" conductors at boxes, fittings or cabinets where a change of raceway alignment occurs.
- K. Install wiring at outlets with at least 6 inches of slack conductor at each outlet.

3.5 CONNECTOR INSTALLATION

- A. Clean conductor surfaces before installing lugs and connectors.
- B. Do not cut conductor strands to fit into connectors.
- C. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- D. Terminate conductors 1/0 AWG and larger using compression connectors at the following locations. Install using manufacturer's recommended compression tools and dies:
 - 1. Circuit breakers larger than 100 amperes; at smaller circuit breakers use mechanical lugs.
 - 2. Safety switches larger than 100 amperes; at smaller safety switches use mechanical lugs.
 - 3. Transformers.
 - 4. Switchgear, switchboard, panelboard, busway, and motor control center main lugs.

- E. Terminate control conductors using crimp-on terminals. Do not place bare stranded conductors directly under terminal screws.
- F. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.
- G. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
- H. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
- I. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

3.6 INSULATING TAPE AND TUBING INSTALLATION

- A. Insulate splices and taps of irregular shapes with manufactured insulating covers or vinyl tape built up to not less than 150 percent of insulation rating of conductor.
- B. Insulate cylinder shaped splices and taps, connector barrels and adapter barrels using heat shrinkable insulating tubing or insulating covers manufactured for the connector.

Delete this article when Type MC Cable is not used.

3.7 TYPE MC CABLE INSTALLATION

- A. Install MC cables according to NECA 1 *Standard Practices for Good Workmanship in Electrical Construction*, the NEC, and requirements in this Section.
- B. Route MC cables to meet Project conditions.
- C. Use Type MC cables for 15- and 20-ampere branch circuit wiring beyond the first outlet or junction box; however, use conduit for the "homerun" from the first outlet or junction box to the branch circuit panelboard.
- D. Use Type MC cables in interior, dry locations where it will be concealed above ceilings, in dry-wall partitions, in equipment enclosures, or below raised floors. Type MC cables may be installed exposed in dedicated electrical rooms and mechanical rooms if it will not be exposed to physical damage or deteriorating agents.
- E. Install and support Type MC cables as required in Article 330 of the 2002 NEC. Use NRTL listed spring steel MC cable supports or UV resistant plastic tie wraps to support Type MC cables; do not use wire to support Type MC cables

3.8 IDENTIFICATION

- A. Identify wire and cable under provisions of Section 16075 *Electrical Identification*.
- B. Identify each conductor with its circuit number or other designation indicated on Drawings.

- C. Apply color coding tape on conductors at each termination, splice, junction, and pull box.
- D. Post conductor color code on each panelboard, switchboard, switchgear assembly, motor control center, dry-type transformer, safety switch and separate motor controller. Use type-written, adhesive-backed labels

3.9 FIELD QUALITY CONTROL

- A. Upon installation of wires and cables and before electrical circuitry is energized, show product capability and compliance with requirements and verify by testing that conductors are free from shorts and unintentional grounds.
- B. Perform the following inspections and tests:
 - 1. Inspect wire for physical damage and proper connection according to the Drawings.
 - 2. Measure tightness of mechanical connections and compare torque measurements with manufacturer's recommended values. Use a calibrated torque wrench.
 - 3. Check for correct conductor color coding according to Specifications.
- C. Perform the following electrical tests:
 - 1. Use an ohmmeter to verify the insulation of each service, feeder and critical branch circuit conductor with respect to ground and other conductors in the same raceway. (A critical branch circuit is one providing power to a fire alarm system, emergency lighting system, or safety system.)
 - 2. Test continuity of each power circuit conductor.
 - 3. Test continuity of each control circuit conductor.
- D. Remove and replace defective conductors and retest.
- E. Refer to Section 16080 *Electrical Acceptance Testing* for other inspections and tests that are required before conductors may be energized.

END OF SECTION

Do not delete the following reference information:

FOR LANL USE ONLY

This project specification is based on LANL Construction Specification 16120, Rev. 2, dated April 9, 2004.